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RADIATION SURVEY OF DWELLINGS IN CANE VALLEY, ARIZONA AND UTAH, FOR USE OF URANIUM MILL TAILINGS

Joseph M. Hans, Jr., et al

Office of Radiation Programs
Las Vegas, Nevada

August 1975

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Las Vegas, Nevada 89114

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A radiation survey was conducted in the Cane Valley area of Monument Valley, on the Navajo Reservation, to identify dwellings in which uranium mill tailings had been used and to assess the resulting radiation exposures. Sixteen of the 37 dwellings surveyed were found to have tailings and/or uranium ore used in their construction. Tailings were used in concrete floors, exterior stucco, mortar for stone footings, cement floor patchings, and inside as cement "plaster". Uranium ore was found in footings, walls, and in one fireplace. Other structures, not used as dwellings, were also identified as having tailings and ore use.

Gamma ray exposure rates were measured inside dwellings and structures identified as having tailings and/or ore used in their construction. Indoor radon progeny samples were collected in occupied dwellings where practical.

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PREFACE

The Office of Radiation Programs of the Environmental Protection Agency carries out a national program designed to evaluate population exposure to ionizing and non-ionizing radiation, and to promote development of controls necessary to protect the public health and safety. This radiation survey was undertaken to assess the extent of the use of uranium mill tailings and ore in Cane Valley residences on the Navajo Reservation and to evaluate the ensuing human exposure as a result of their use. Readers of this report are encouraged to inform the Office of Radiation Programs of any omissions or errors. Comments or requests for further information are also invited.

Donald W. Hendricks
Director, Office of
Radiation Programs, LVF

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INTRODUCTION

A "screening" survey, conducted in early February 1975 by the Navajo Environmental Protection Commission (NEPC), indicated the use of uranium mill tailings and uranium ore in the construction of several dwellings in the Monument Valley area. The dwellings are located on the Navajo Reservation, approximately 17 miles southwest of Mexican Hat, Utah, near the Vanadium Corporation of America's former uranium mill site.

As a result of informal discussions with members of NEPC and the Indian Health Service of the U.S. Public Health Service (PHS, IHS), it was jointly decided to conduct a follow-up survey of all the dwellings and structures in the area for tailings and ore use and to measure the resulting radiation exposures.

SUMMARY

A radiation survey was conducted in the Cane Valley area of Monument Valley, on the Navajo Reservation, to identify dwellings in which uranium mill tailings had been used and to assess the resulting radiation exposures. Sixteen of the 37 dwellings surveyed were found to have tailings and/or uranium ore used in their construction. Tailings were used in concrete floors, exterior stucco, mortar for stone footings, cement floor patchings, and inside as cement "plaster". Uranium ore was found in footings, walls, and in one fireplace. Other structures, not used as dwellings, were also identified as having tailings and ore use.

Gamma ray exposure rates were measured inside dwellings and structures identified as having tailings and/or ore used in their construction. Indoor radon progeny samples were collected in occupied dwellings where practical.

CONCLUSIONS

Uranium mill tailings and ore have been used extensively for construction by the Cane Valley residents. The source of the tailings and ore is the inactive uranium mill site (formerly operated by the Vanadium Corporation of America) and an adjacent open-pit mine, which are located in the Valley. The reason for their use is that the residents have unrestricted access to the white sands of the tailings pile and the broken stone at the mine and former ore storage area.

The most predominant use of tailings and ore was found to be in residential structures and has resulted in elevated radiation exposures to the occupants of these structures. Tailings were incorporated directly into the floor, foundation materials, and exterior stucco. This is not similar to their use in dwellings in Grand Junction, Colorado, where they were used primarily as bedding material for floors and foundations.(1)

The highest net average gamma exposure rate measured three feet above an inside floor was 332 mR/yr and the highest net corrected average exposure rate at floor level was 402 mR/yr. If the tailings from the nearby Mexican Hat mill site had been used, the exposure rates would have been increased by nearly ten fold.

Indoor radon progeny samples collected in the Valley residences were essentially "grab" samples and may not reflect long-term averages. It is likely they are low because temperate weather prevailed during the survey and the dwellings were well ventilated. The highest indoor radon progeny level measured during the survey was 0.046 net Working Level (WL).

In order to establish long-term indoor radon progeny levels, "Track Etch" badges will be installed in selected, occupied dwellings.(2)

SURVEY PARTICIPANTS

Several Federal and State agencies and the Navajo Nation, through NEPC, assisted the U. S. Environmental Protection Agency's Office of Radiation Programs--Las Vegas Facility (EPA, ORP-LVF) staff in conducting the survey. The participants and parent organizations are listed below:

Joseph M. Hans, Jr.	EPA, ORP-LVF
Richard L. Douglas	" " "
Dr. James K. Channell	EPA, Region IX
Jack Womack	PHS, IHS
Albert Bailey	" "
John L. Thompson	" "
Ray Van Ostran	" "
Ralph B. Ochoa	Arizona Atomic Energy Commission
Thomas A. Schell	" " " "
Benjamin Manygoats	NEPC

PURPOSE OF SURVEY

The survey was conducted to determine the extent of use of uranium mill tailings and uranium ore in structures in and around Cane Valley, and to assess the resulting potential human exposures. Specific objectives of the survey are listed below:

1. To confirm the findings of the "screening" survey.

2. To screen other structures in and around Cane Valley for tailings and ore use.

3. To measure the ambient exposure rates in structures containing tailings and ore.

4. To screen dwellings containing tailings and/or ore for indoor radon progeny levels.

5. To assess the need for any additional sampling or measurement followup.

SURVEY EQUIPMENT AND USE

Several types of radiation survey equipment were used to identify structures containing tailings and/or ore. They are listed and briefly described below, along with how they were used in the survey:

Pressurized Ion Chamber

A pressurized ion chamber (Reuter-Stokes RS-111) is an exposure rate measuring device capable of evaluating exposure rates in the microroentgen per hour range. It was used to measure exposure rates three feet above ground and floor levels inside and outside of structures.

Shielded Scintillometer

A shielded scintillometer is a rate meter (Baird Atomic NE-148) utilizing a sodium iodide crystal as a detector and is capable of measuring relative exposure rates in the microroentgen per hour range. A sliding shield was used in conjunction with the scintillometer, which could be interposed between the detector and an object being measured. Measurements were taken on contact with objects (floors, walls, foundations, etc.) of interest with (closed reading) and without (open reading) the shield in place. The magnitude of the difference of the two readings (Δ) gave an indication of whether tailings and/or ore were or were not present in the object.

An estimate of the true net exposure rate was made by subtracting a background value from an open reading and multiplying the difference by 0.56 and adding 0.9.(1) This instrument was used to determine the presence of tailings and/or ore and to estimate the Ground-Floor Gamma (GFG) exposure rates.

Radon Progeny Air Samplers

A radon progeny air sampler is a particulate air sampler which collects radon progeny on a filter. A known fraction of the energy of ionizing radiation emitted by the radon progeny is stored in the thermoluminescent dosimeters These dosimeters are "interrogated" and the resulting energy deposition is expressed in terms of Working Level (WL). One (WL) is defined as any combination of radon daughters in one liter of air that will result in the ultimate emission of 1.3×10^5 MeV of potential alpha energy.

These samplers were used to screen occupied structures for high (WL) values and to serve as indicators for the need for further sampling.

Portable Generators

Since no electrical power is available in Cane Valley, gasoline-engine portable electric generators were used to provide power for the indoor radon progeny samplers.

SURVEY PROCEDURES

A Navajo Chapter member, representing the Cane Valley residents, was requested, by NEPC, to advise the residents that radiological surveys would be made in and around their dwellings.

An orientation session was conducted for the survey team participants at the Mexican Hat uranium mill site to review instrument operation and develop survey procedures. The team was divided into two groups. One group, with an interpreter, proceeded to screen structures and dwellings in and around the Valley for tailings and ore use. The remaining group conducted surveys on dwellings previously identified as containing tailings and/or ore.

Many of the Valley residents live in family clusters and these clusters were identified as residential locations in the survey. Permission was requested from the family head to survey the structures in the clusters. The names and ages of the occupants were recorded, where possible, and measurements with the shielded scintillometer were made in and around the dwellings to determine if ore or tailings were used for construction or other purposes. If the use of ore or tailings was indicated, pressurized ion chamber measurements were made, where possible, inside the dwellings to determine the ambient exposure rate at three feet above the floors.

After tailings use was confirmed and exposure rate levels were measured, indoor radon progeny samplers were placed in occupied structures. The samplers were removed the following day and placed in other occupied structures and the cycle was repeated.

Background measurements were made with pressurized ion chambers at several locations off the road and away from washes in the Valley. These and the residential locations are indicated on the Monument Valley map (Figure 1).

Water samples were collected from one artesian and four hand-pumped wells during the Valley surveys. Radium-226 concentrations are listed in Table 1.

SURVEY RESULTS

Table 2 provides a summary of the 17 locations surveyed.

The survey results at each location are discussed individually. A sketch of the structures at each location is included with measurements indicated at the approximate point where they were made. Scintillometer measurements are indicated by triangles. Gross, uncorrected, unshielded measurements are on the left side and gross, uncorrected, shielded measurements are on the right side of the triangles. The difference between these two measurements is indicated in the center of the triangle and letters beneath the triangles indicate the object measured. A difference or Δ value greater than two indicates the presence of tailings and/or ore.

Table 1. RADIUM-226 CONCENTRATIONS
IN CANE VALLEY WELL WATER

Location Number	Radium-226 (pCi/1)
16	0.25
15	0.36
8	0.11
6	0.15
4	0.11

Table 2. SUMMARY OF LOCATIONS SURVEYED

Location Number	Owner/Occupant	Residential Structures Surveyed	Residential Structures With Tailings Use	Comments
1	Ned Yazzie	2	1	Highest measurements.
2	Tony Yazzie	3	2	Includes house under construction.
3	Ben Stanley	2	2	Includes house under construction.
4	Luke Yazzie	2	1	
5	Anna Adekai (Cly)	2	2	
6	Don Wilson	3	1	
7	Belva Johnson	1	0	
8	Thomas Adekai	1	0	
9	Jean Yellowman	4	1	Tailings used in open-log structure used as summer house.
10	Cecil Blackmountain	2	2	
11	Woody Benali	4	0	Ore; no tailings.
12	Jesse Black	1	1	
13	Juanita Black (Jackson)	1	1	
14	Oscar Sloan	3	1	
15	Bessie Yellowman	4	0	Well structure had tailings use.
16	--	0	0	Artesian well structure had tailings use.
17	Yellowman Begay	2	1	

Locations 9-11 and 15-17 are in Utah; the others are in Arizona.

Pressurized ion chamber (PIC) measurements are indicated with circles and the value in the circle is the net exposure rate at three feet above the floor or ground. A legend, attached to each sketch, provides a key for each type of measurement and orientation of the structures.

The discussion contains pertinent information concerning the locations and a summary of the indicated radiation measurements. The summary includes net working level (WL) values and PIC and GFG exposure rates extrapolated to an annual basis. The latter is the average net corrected, unshielded scintillometer measurement on floors. Other appropriate measurements and available family information is included in the discussion.

Residential Location 1 - Ned Yazzie

Two occupied structures are at this location. One is a 13-year-old frame house and the other is a hogan, which was found to contain no ore or tailings. Tailings were found to have been used in stucco on all four walls of the the house and in cement used in the floors, including the patio. In addition, some tailings have been lost or spread on the ground around the patio and also incorporated into the patio slab.

Twelve persons reside at this location, including two five-year-olds and three teenagers.

	House		
	High (mR/yr)	Low (mR/yr)	Average (mR/yr)
PIC	393	253	332
GFG	594	349	402

(WL) - 0.046 for sampling time of 23.6 hours

Residential Location 2 - Tony Yazzie

Four structures are at this location of which two are used for occupancy by eight adults and two children, one is used for storage, and one is a house under construction.

Storage Shed

	High (mR/yr)	Low (mR/yr)	Average (mR/yr)
PIC	183	96	140
GFG	314	169	241

Tailings and/or ore are suspected to have been used beneath the wood floor in the storage shed because of large Δ values and elevated PIC measurements. In addition, tailings have been used in the outside slab and appear to have been spread on the ground behind this structure. Approximately 100 feet west of this structure is an artesian well which has tailings used in cement around its casing.

North House

	High (mR/yr)	Low (mR/yr)	Average (mR/yr)
PIC east side	131	70	102
GFG east side	-	-	169
PIC west side	-	-	35
GFG west side	-	-	18

The house on the north side of this location is occupied and has tailings and/or ore used in the floor of the east side. A fireplace, constructed from ore, was voluntarily removed by the owner. The west side is used for sleeping quarters and the east side is used for family activities. Indoor radon progeny sampling on the east side for 18 hours indicated a net of 0.0017 (WL).

Southeast House

	High (mR/yr)	Low (mR/yr)	Average (mR/yr)
PIC	35	17	26

The southeast house is also occupied, but no tailings or ore were found in or immediately adjacent to the structure. However, gamma exposures were above background, which is probably due to tailings in the driveway and "shine" from the mill tailings pile. An indoor radon progeny sample was collected in this structure to determine a background which was 0.0029 (WL).

Southwest House

A frame house is under construction on the southwest side of this location. Mortar used in the stone foundation contains some tailings but does not appear to have increased the ambient exposure rate inside the structure.

Residential Location 3 - Ben Stanley

Two structures are at this location. One is under construction and the other has ten occupants. Eight of the ten are less than 13 years old.

North Structure

	High (mR/yr)	Low (mR/yr)	Average (mR/yr)
PIC	17	17	17
GFG	Bckgrnd	Bckgrnd	Bckgrnd

Some tailings were present in the mortar used for the foundation in the house under construction. Indoor radon progeny sampling for 23 hours indicated a net of 0.011 (WL). PIC measurements indicated exposure rates slightly above background due to tailings use and proximity to the mill tailings site. No tailings or ore were found to have been used in the floor.

South Structure

	High (mR/yr)	Low (mR/yr)	Average (mR/yr)
PIC	-	-	79
GFG	120	62	80

Tailings and/or ore have been used in the floor of the occupied structure on the south side of this location and the outside entrance slab. Radon progeny sampling for 23 hours indicated a net 0.0025 (WL).

Residential Location 4 - Luke Yazzie, Sr.

Three structures are at this location, one of which is a storage shed. The other two are occupied by four adults and four children, under 14 years of age.

North Structure

	High (mR/yr)	Low (mR/yr)	Average (mR/yr)
PIC	26	26	26

The structure on the north side of the location was found free of tailings use; however, several pieces of ore were used for the foundation. Indoor gamma exposure rates were above background and were essentially the same as outdoor exposure rates. This is probably due to the close proximity of the uranium mill tailings pile.

Hogan

	High (mR/yr)	Low (mR/yr)	Average (mR/yr)
PIC	-	-	70

Tailings were used for cement finishing on the walls inside the hogan. An indoor radon progeny sample collected for 13 hours indicated a net 0.0042 (WL).

A well, located approximately 200 feet west of the hogan, had tailings used in its construction. The storage shed was found to be free of ore and tailings.

Residential Location 5 - Anna Adekai (Cly)

Two structures, occupied by eight adults and one infant, are at this location. Both structures are approximately the same size and have the same type of construction.

North Structure

	High (mR/yr)	Low (mR/yr)	Average (mR/yr)
PIC	44	35	40
GFG	23	13	17

Tailings and/or ore have been used in the foundation of this structure. It also appears that a small quantity of tailings have been used in the exterior stucco on the north wall. There is no indication of tailings or ore beneath the wood floors. Indoor radon progeny was sampled for 21 hours indicating a net of 0.0002 (WL).

South Structure

	High (mR/yr)	Low (mR/yr)	Average (mR/yr)
PIC	96	70	83
GFG	115	71	81

Tailings and/or ore appear to have been used beneath the wood floors, in the stone foundation, and in the outdoor step pad. Tailings also have been used in the outside stucco on all four walls. A cement block foundation (about 1 foot high) on the south side of the structure was found free of tailings use. An indoor radon progeny sample collected for 13 hours indicated a net 0.0011 (WL).

Residential Location 6 - Don Wilson

Four structures at this location, three hogans and one frame house, are occupied by three adults, four teenagers, and two children (ages 7 and 4).

Frame House

	High (mR/yr)	Low (mR/yr)	Average (mR/yr)
PIC	26	17	22
GFG	23	18	21

An indoor radon progeny level sampler operated for 15 hours indicated 0.0019 net (WL).

Tailings were used in exterior stucco and on all four walls and appear to have been used in footing cement in the frame house.

Hogans

No tailings or ore were found to have been used in the hogans.

Residential Location 7 - Belva Johnson

The two structures at this location consist of a wood hogan with a dirt floor and a canvas-covered wood storage shed. No indication of tailings or ore was found at this location.

Residential Location 8 - Thomas Adekai

An adobe hogan and plywood building are the only structures at this location. No tailings or ore was found in or around these structures.

Residential Location 9 - Jean Yellowman

No tailings or ore were found in the three hogans at this location; however, tailings and ore have been used in the log structure foundation as mortar and patching.

Occupancy of the loosely spaced log wall structure is limited to summers because it is cooler than the hogans. The owner indicated that tailings material had been used in a former hogan.

Residential Location 10 - Cecil Blackmountain

Two structures at this location are used for occupancy; however, no one was occupying the north structure and a temporary occupant and family were using the south structure.

North Structure

	High (mR/yr)	Low (mR/yr)	Average (mR/yr)
PIC	140	61	90
GFG	277	96	85

The north structure had tailings and/or ore used in the cement floor. The (WL) value was background for a 20-hour sample.

Residential Location 11 - Woody Banali Hogans

No tailings use was found at this location; however, ore has been used around the entryways on the outside of the east and south hogans.

Residential Location 12 - Jessie Black

This residential structure, used as a summer house, has tailings used for mortar for the concrete block walls and in the concrete footing, as well as in the cement floor. Tailings have also been used in the cemented log walls and floor in the south section of the house. The foundation on the south section probably contains tailings and/or ore. Ore was found on the ground outside the south side of the house.

Since the structure was unoccupied at the time of the original survey, IHS staff returned at a later date to complete the inside measurements. Since a PIC was not available, gamma ray exposure rates were measured with a scintillometer three feet above the floor over the positions ground-floor gamma exposure rates were made.

	Summer House		
	High (mR/yr)	Low (mR/yr)	Average (mR/yr)
(Net corrected scint. meas. @ 3 ft. above floor)	169	67	113
GFG	228	96	149

An indoor radon progeny sample collected for 18 hours indicated a net 0.0033 (WL).

Residential Location 13 - Juanita Black

The structure at this location is occupied by two adults, three teenagers, and four children. Tailings have been used in the stucco on the walls on the east side of the house. It appears that some tailings and/or ore is present beneath the wood flooring; also, tailings are on the ground on the east and south sides of the house.

	House		
	High (mR/yr)	Low (mR/yr)	Average (mR/yr)
PIC	61	44	52
GFG	47	37	44

Indoor radon progeny were sampled for 17.6 hours in this structure, resulting in a net 0.0032 (WL).

Residential Location 14 - Oscar Sloan

This residential location was not occupied during the survey and only outside measurements could be made. Tailings were found to have been used in the stucco on all four walls of the center structure. They were also used in the mortar for the patio stone floor.

Inside measurements were completed at a later date by the IHS staff and the results of these measurements indicate tailings have been used in the cement floor. Since a PIC was not available, gamma ray exposure rates were measured with the scintillometer three feet above the floor over the positions ground-floor gamma exposure rates were made.

	House		
	High (mR/yr)	Low (mR/yr)	Average (mR/yr)
(Net corrected scint. meas. @ 3 ft. above floor)	71	27	45
GFG	169	47	104

A seven-hour radon progeny sample, collected in the house, indicated a net working level at background.

Hogan & South Structure

Both the hogan and the south structure were found to be free of ore and tailings use.

Residential Location 15 - Bessie Yellowman

No tailings or ore were found at the Yellowman residence. The nearby Toh Dekais well has tailings and/or ore used in its construction.

Location 16 - Artesian well

The well at this location has a six-foot high tank (with a six-foot diameter) over the well. Tailings and/or ore were used as construction materials for the tank foundation. The well overflow is stored in a mortared stone crib which also had tailings and/or ore used in its construction.

Residential Location 17 - Yellowman Begay

Two houses are occupied at this location. The one to the southwest was found to have no tailings and/or ore used in its construction. Some tailings are suspected to have been used on the concrete floor slab on the east side of the northwest house. Possible use was for leveling or finishing the slab.

No PIC measurements were made at this location.

Northwest House

	High (mR/yr)	Low (mR/yr)	Average (mR/yr)
GFG	.62	Background	28

A net 0.0019 (WL) value was measured for a 17-hour sampling period for indoor radon progeny.

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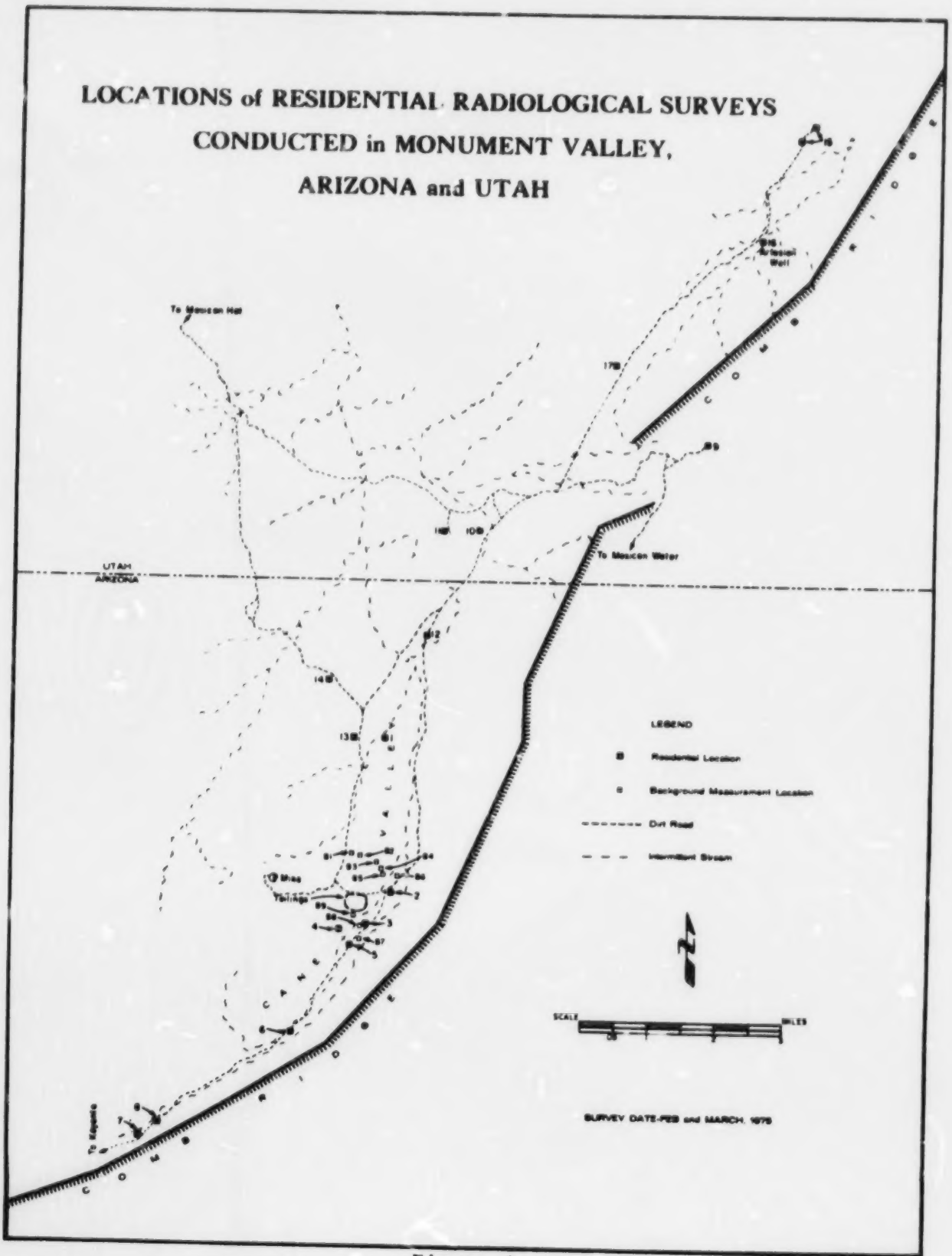

LOCATIONS of RESIDENTIAL RADIOLOGICAL SURVEYS
CONDUCTED in MONUMENT VALLEY,
ARIZONA and UTAH
UTAH
ARIZONA
LEGEND
Residential Location
Dirt Road
SCALE
SURVEY DATE-FEB and MARCH, 1978

Figure 1

RESIDENTIAL LOCATION 1 Ned Yazzie

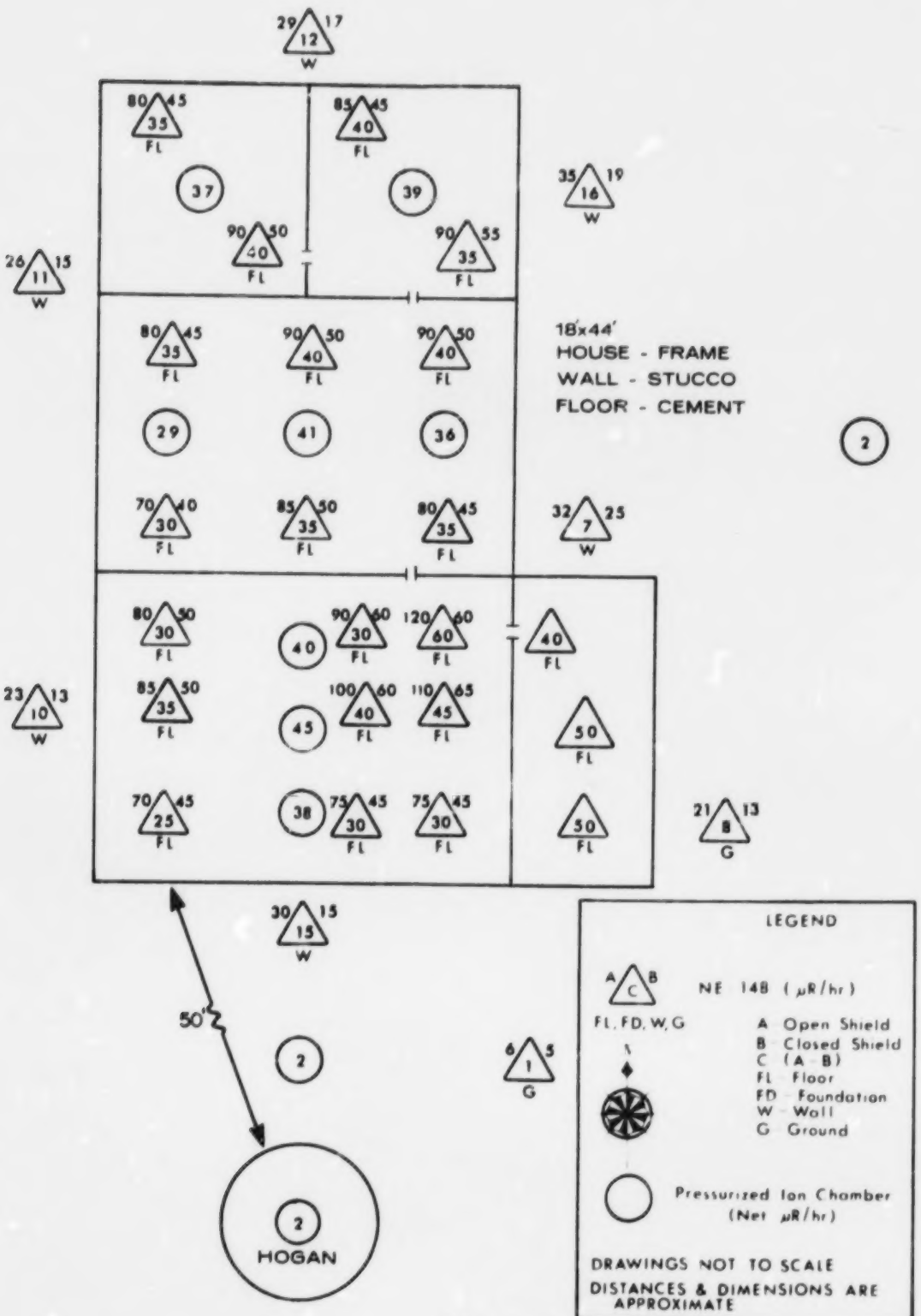


Figure 2

RESIDENTIAL LOCATION 2 Tony Yazzie

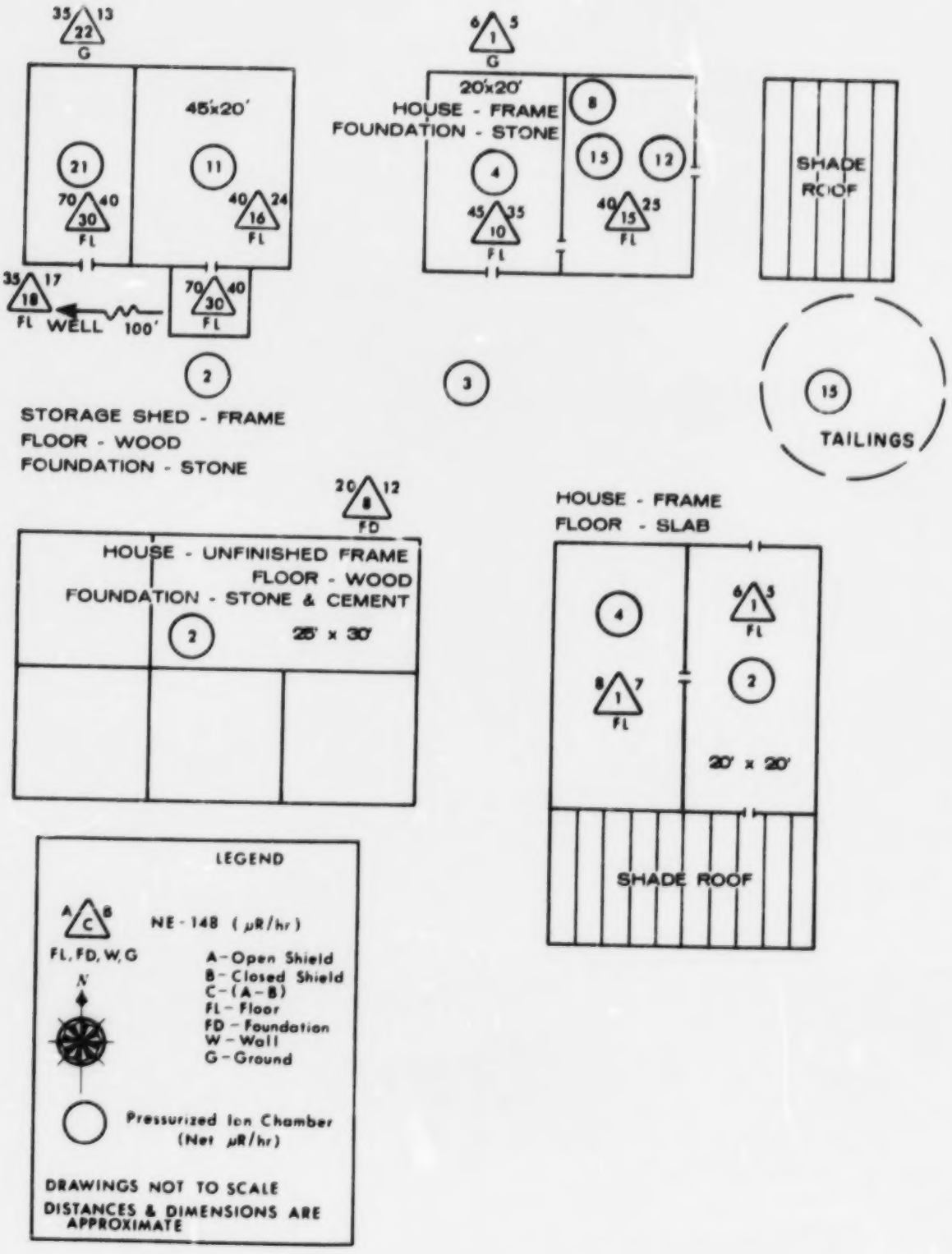


Figure 3

RESIDENTIAL LOCATION 3 Ben Stanley

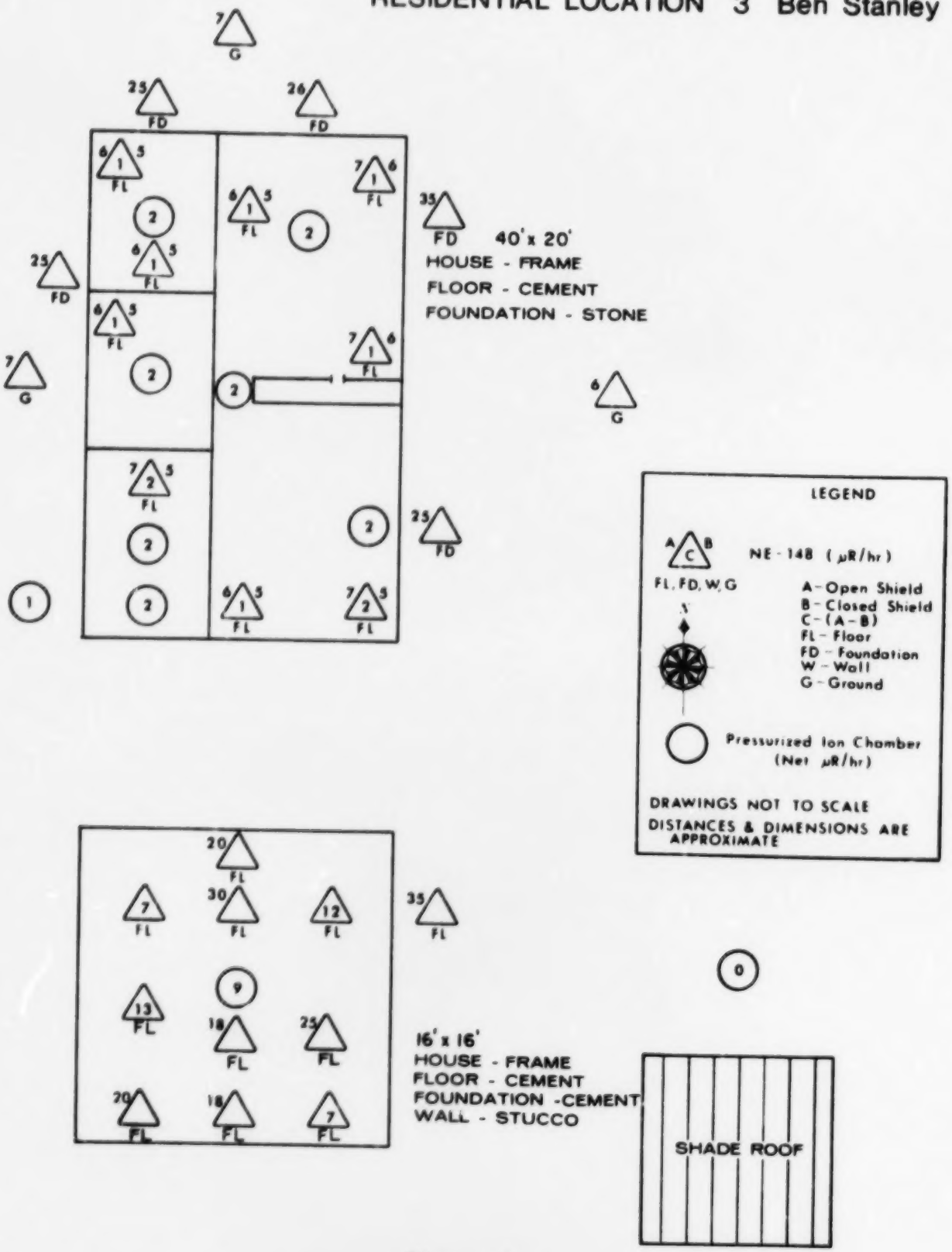


Figure 4

RESIDENTIAL LOCATION 4

Luke Yazzie, SR.

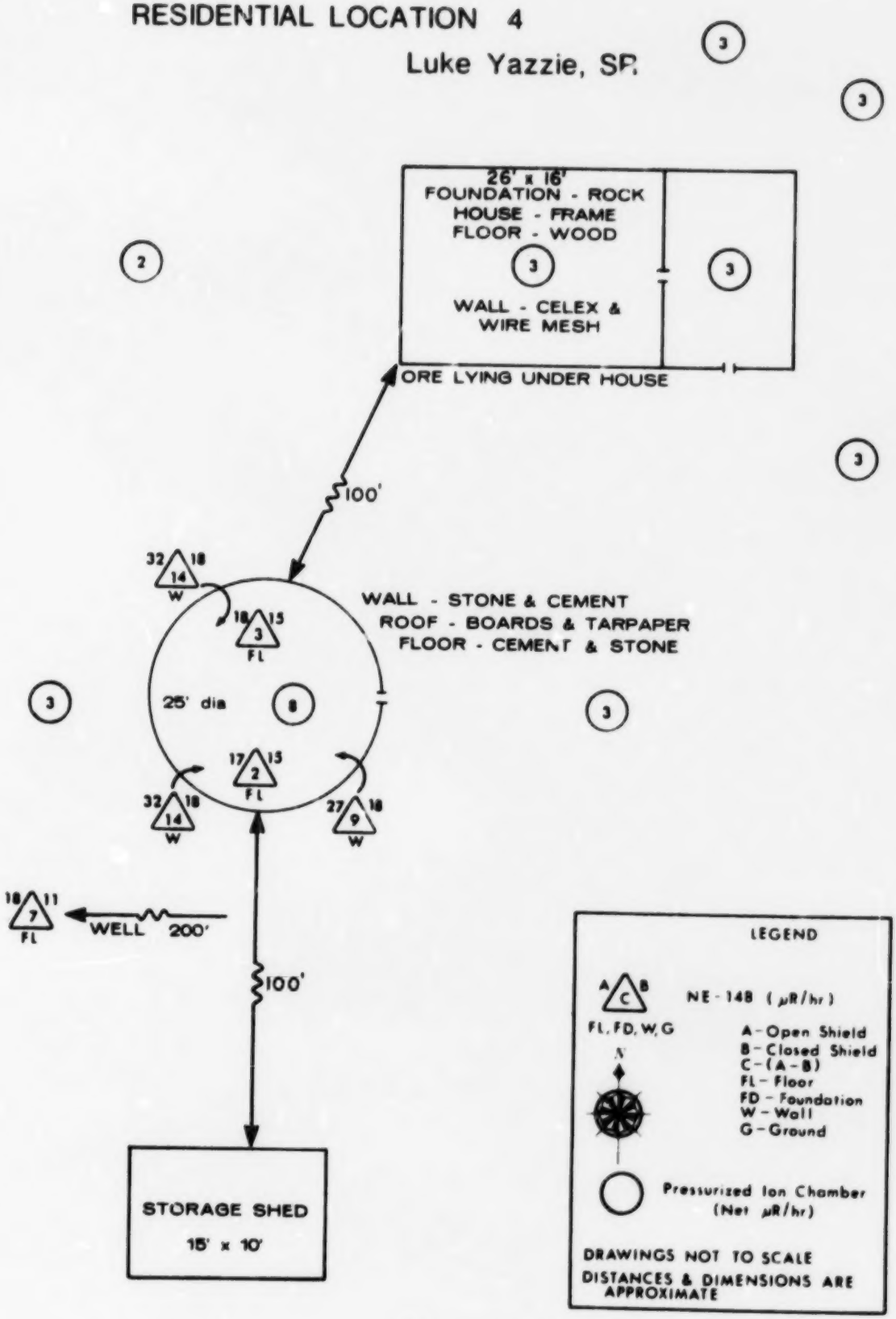


Figure 5

RESIDENTIAL LOCATION 5

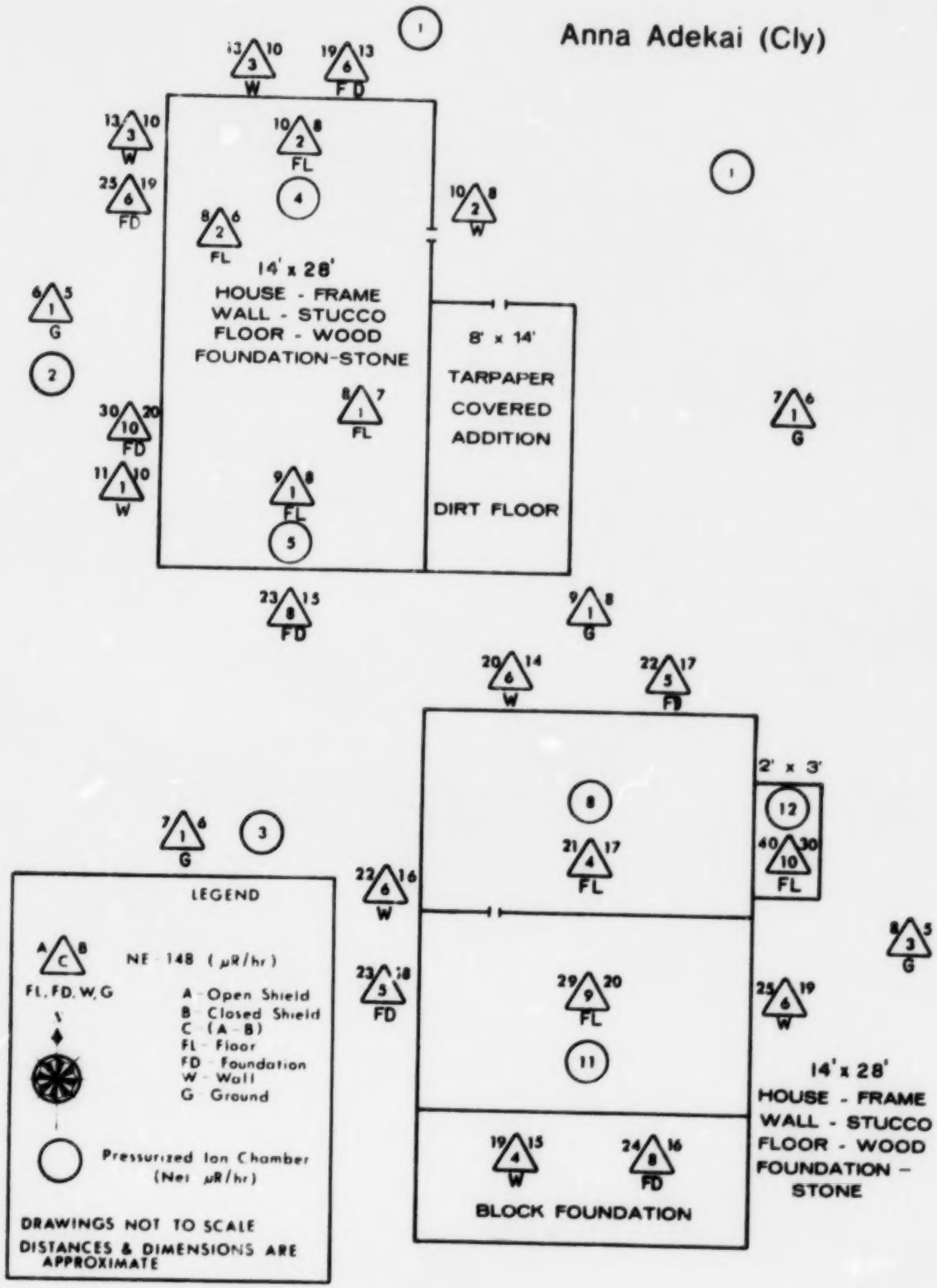


Figure 6

RESIDENTIAL LOCATION 6 Don Wilson

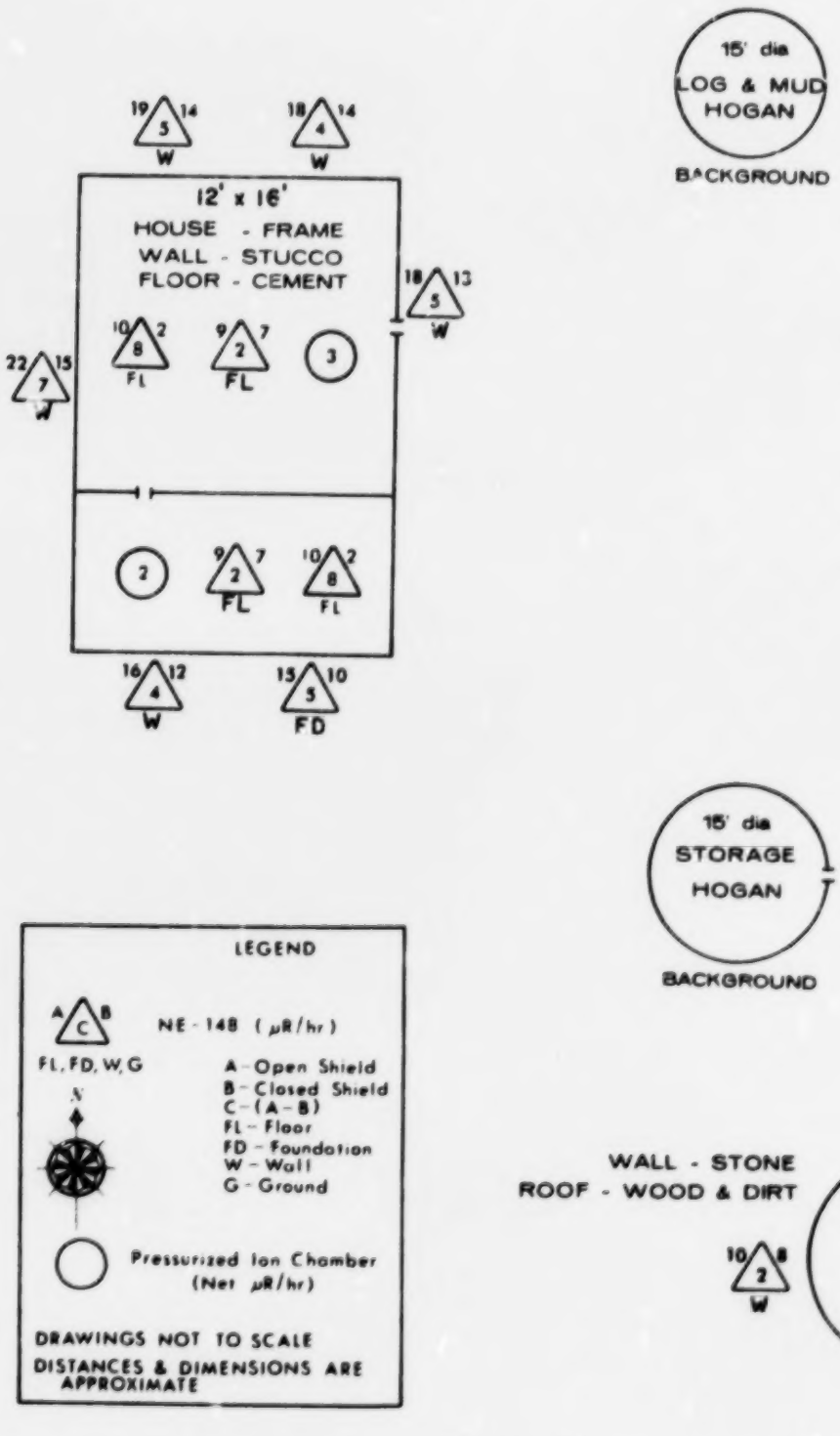


Figure 7

RESIDENTIAL LOCATION 7 Belva Johnson

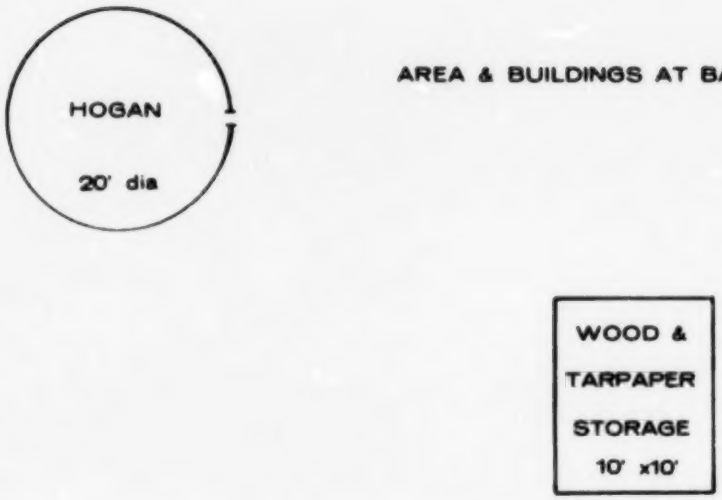


Figure 8

RESIDENTIAL LOCATION 8 Thomas Adekai

AREA & BUILDINGS AT BACKGROUND

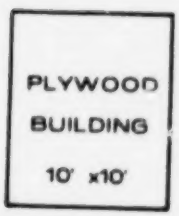


Figure 9

RESIDENTIAL LOCATION 9

Jean Yellowman

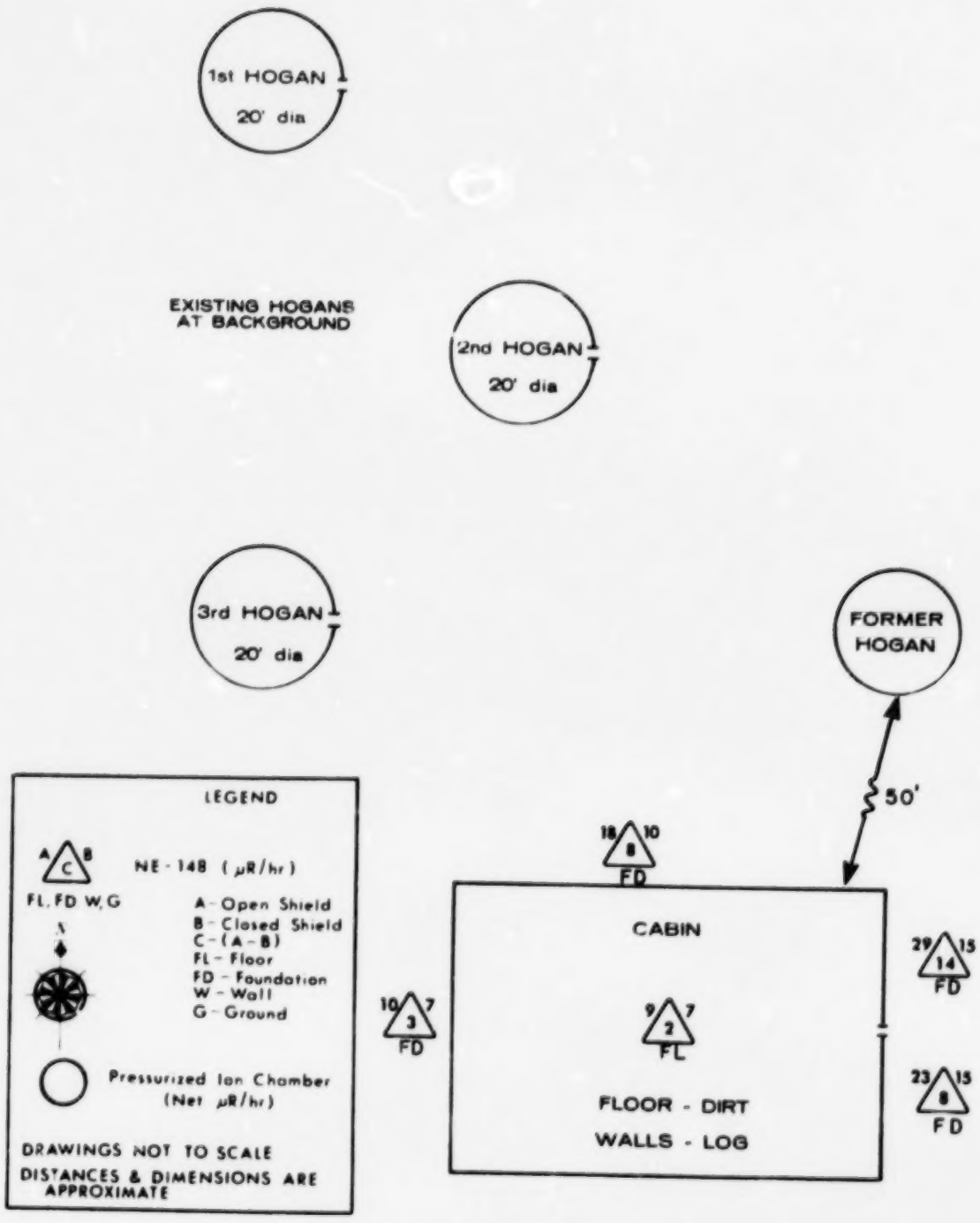


Figure 10

RESIDENTIAL LOCATION 10 Cecil Black Mountain

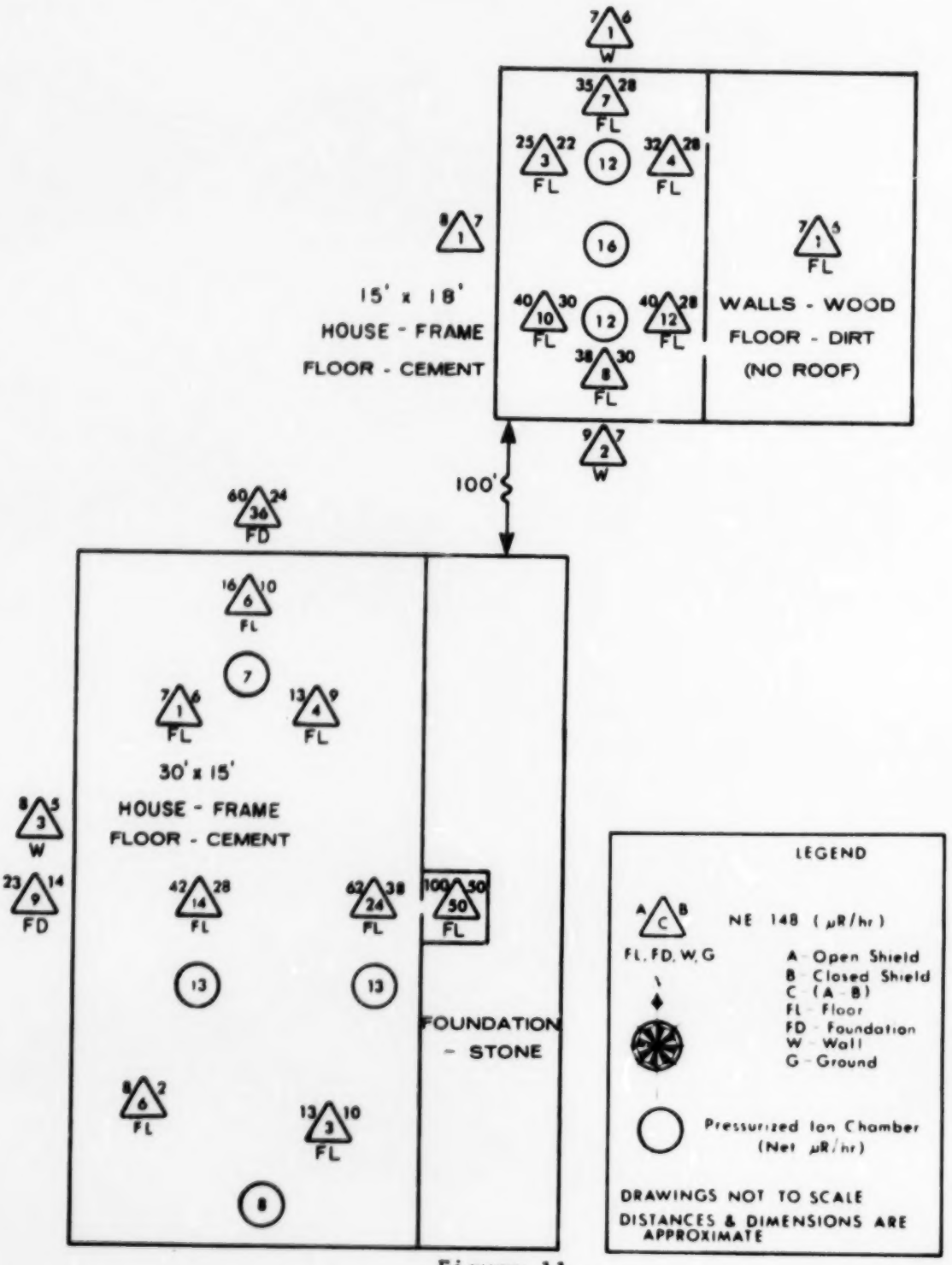


Figure 11

RESIDENTIAL LOCATION 11

Woody Banali Hogans

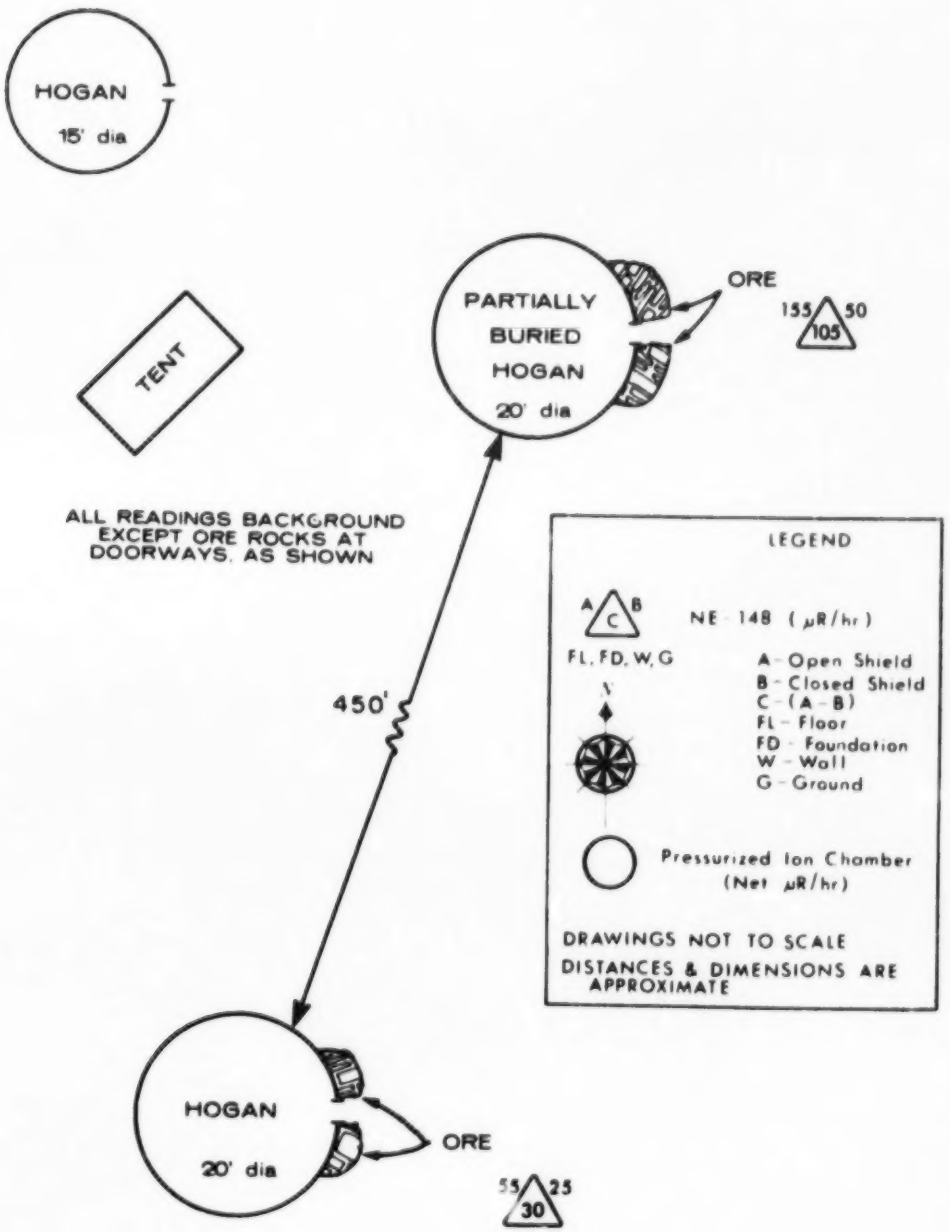


Figure 12

RESIDENTIAL LOCATION 12 Jessie Black

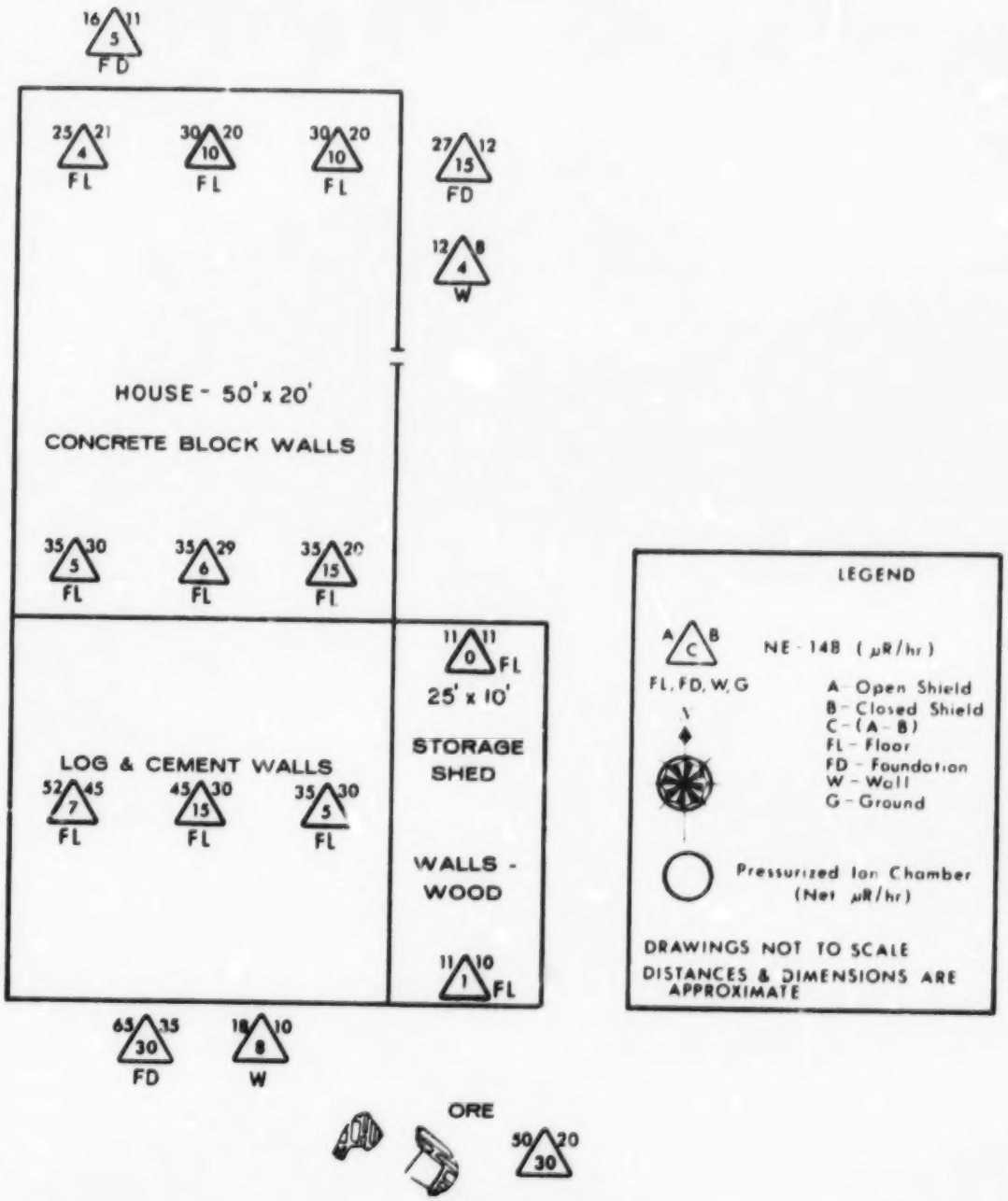


Figure 13

RESIDENTIAL LOCATION 13 Juanita Black

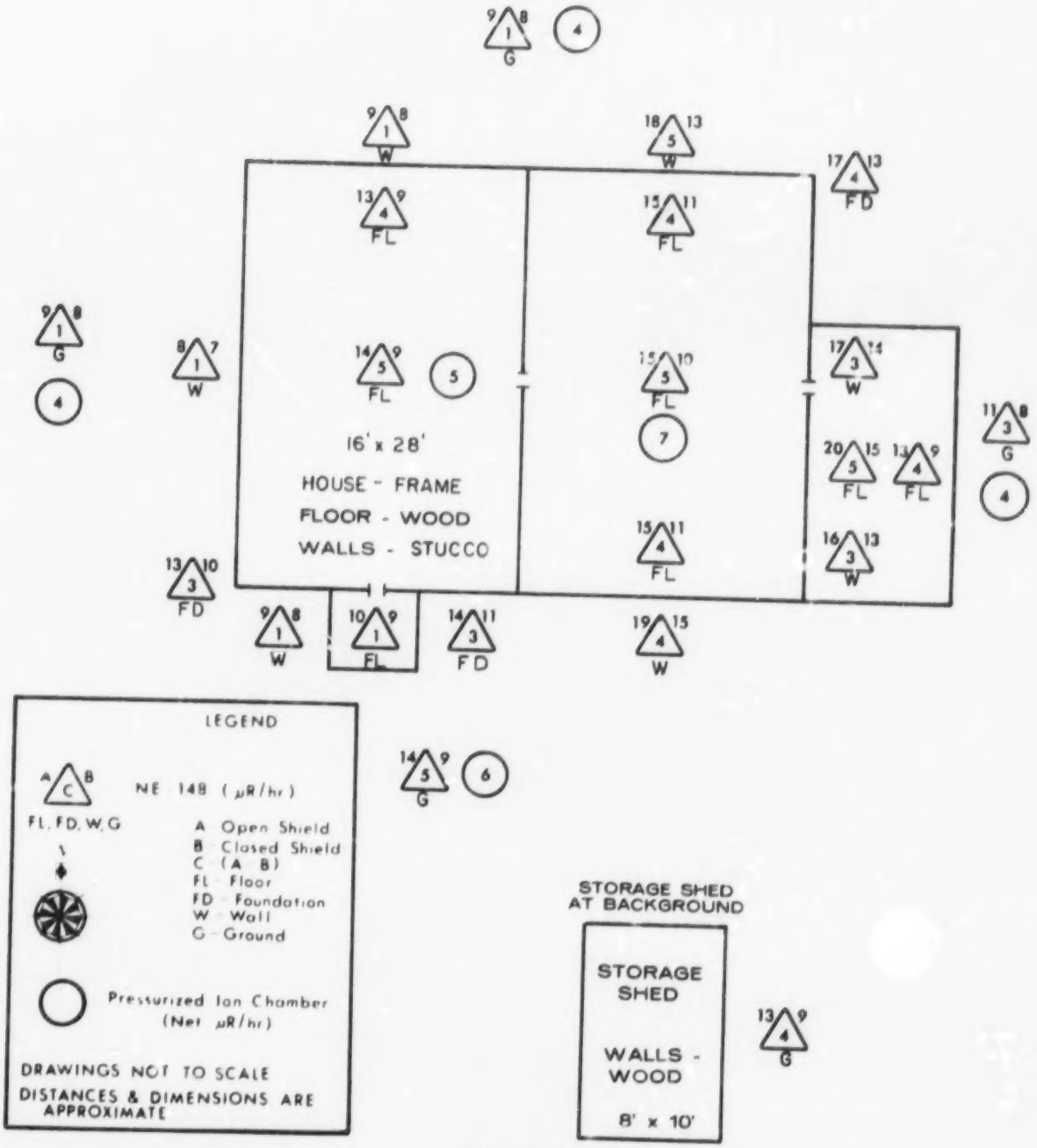


Figure 14

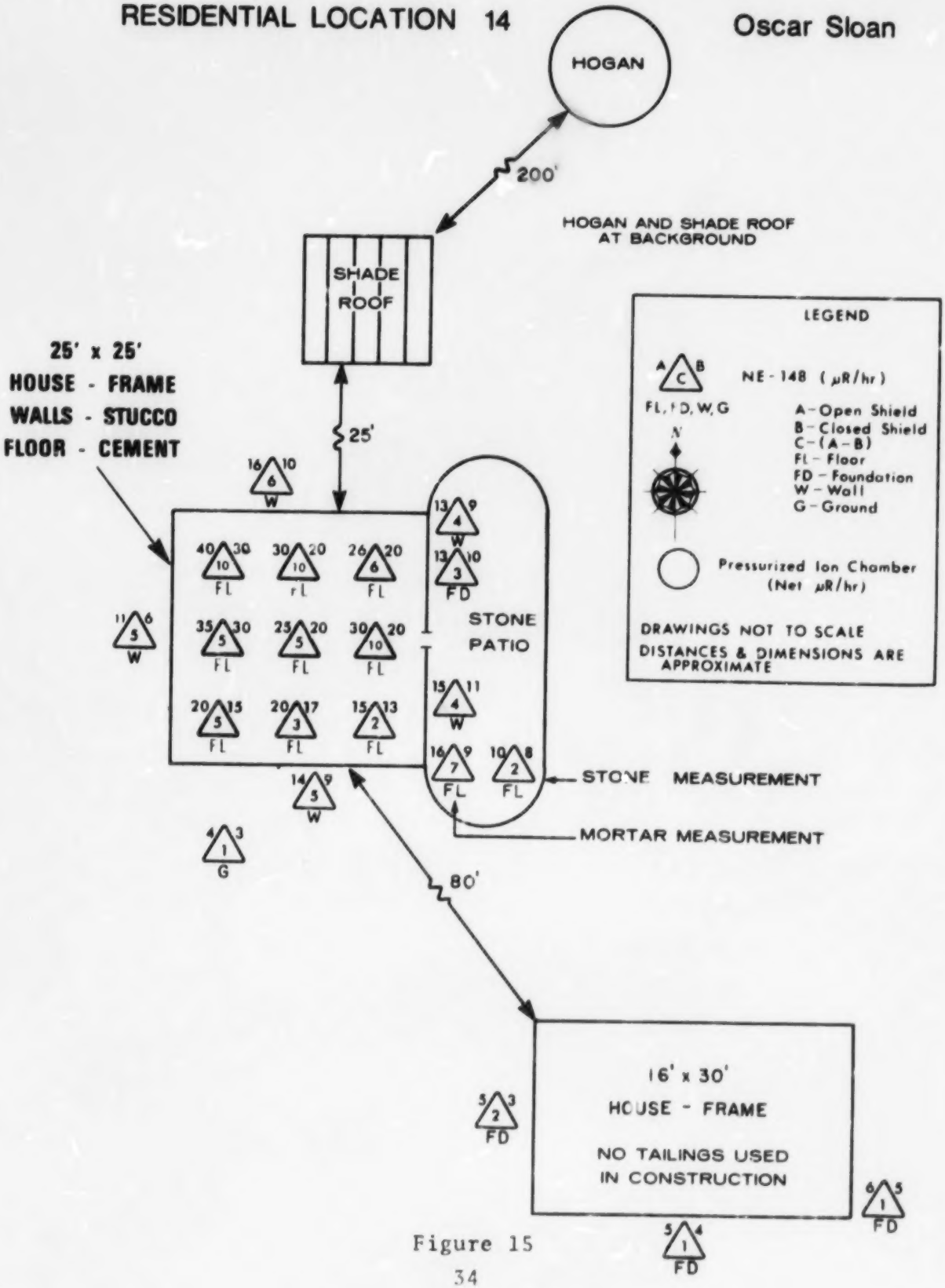
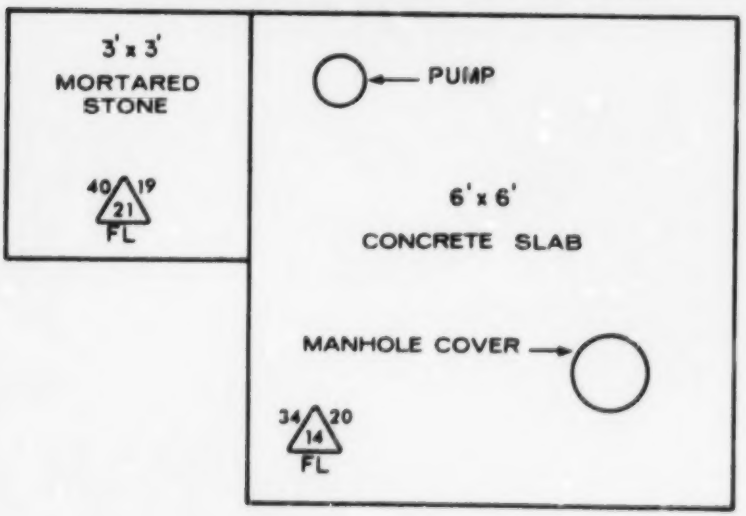
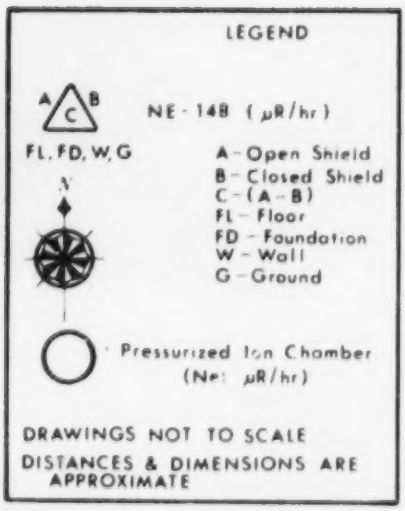

RESIDENTIAL LOCATION 14
Oscar Sloan
HOGAN
200'
HOGAN AND SHADE ROOF AT BACKGROUND
SHADE ROOF
25' x 25'
HOUSE - FRAME
WALLS - STUCCO
FLOOR - CEMENT
25'
STONE PATIO
LEGEND
NE - 148 (μR/hr)
FL, FD, W, G
A - Open Shield
B - Closed Shield
C - (A - B)
FL - Floor
FD - Foundation
W - Wall
G - Ground
N
Pressurized Ion Chamber (Net μR/hr)
DRAWINGS NOT TO SCALE
DISTANCES & DIMENSIONS ARE APPROXIMATE
STONE MEASUREMENT
MORTAR MEASUREMENT
80'
16' x 30'
HOUSE - FRAME
NO TAILINGS USED IN CONSTRUCTION

Figure 15

RESIDENTIAL LOCATION 15 Bessie Yellowman

TOH DEKAIS WELL PROJECT NO. 8-8-3, 4/7/69





YELLOWMAN DWELLING (NOT SHOWN)

NO TAILINGS USED IN CONSTRUCTION

Figure 16

LOCATION 16 ARTESIAN WELL

Completed April 5, 1968

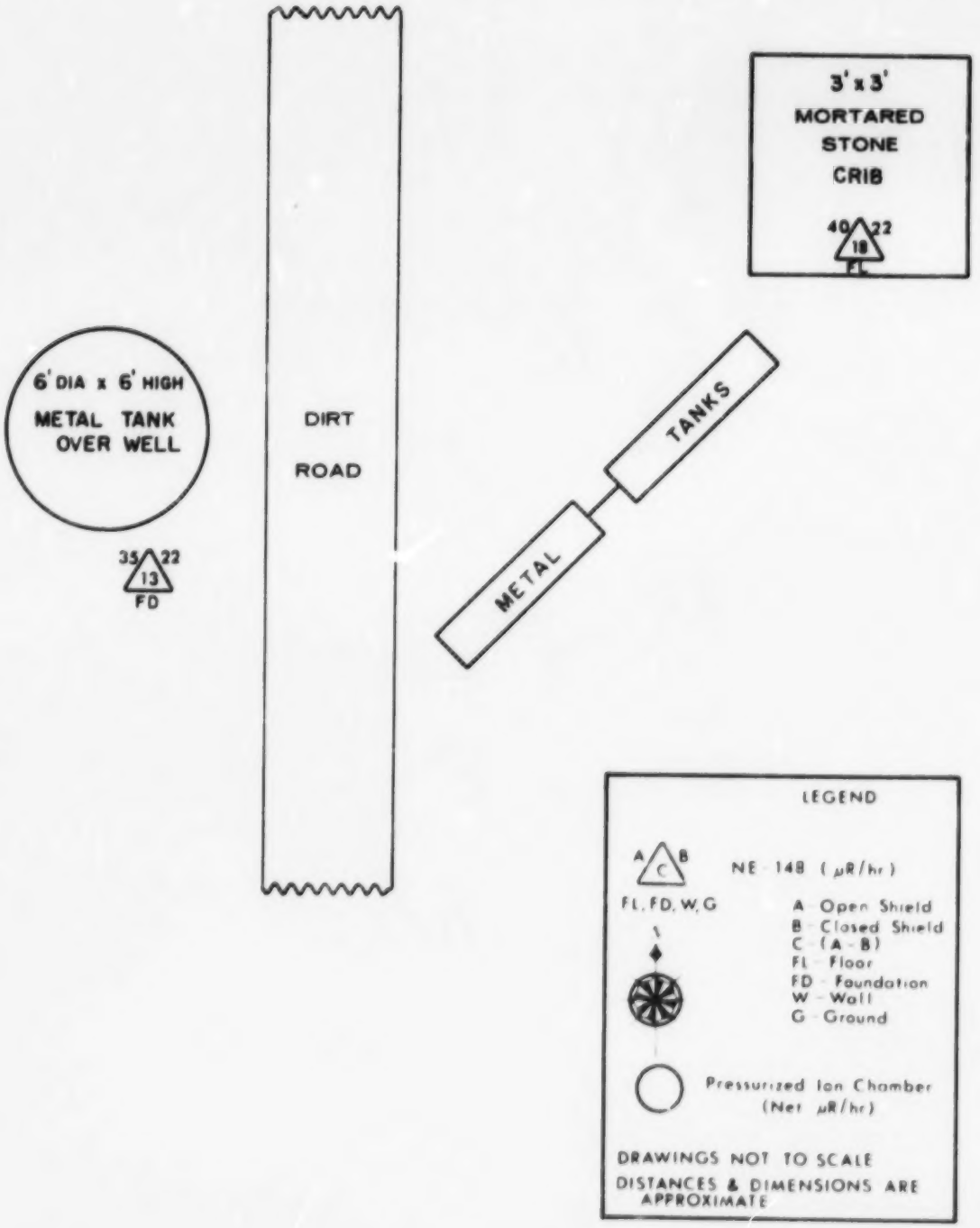


Figure 17

RESIDENTIAL LOCATION 17 Yellowman Begay

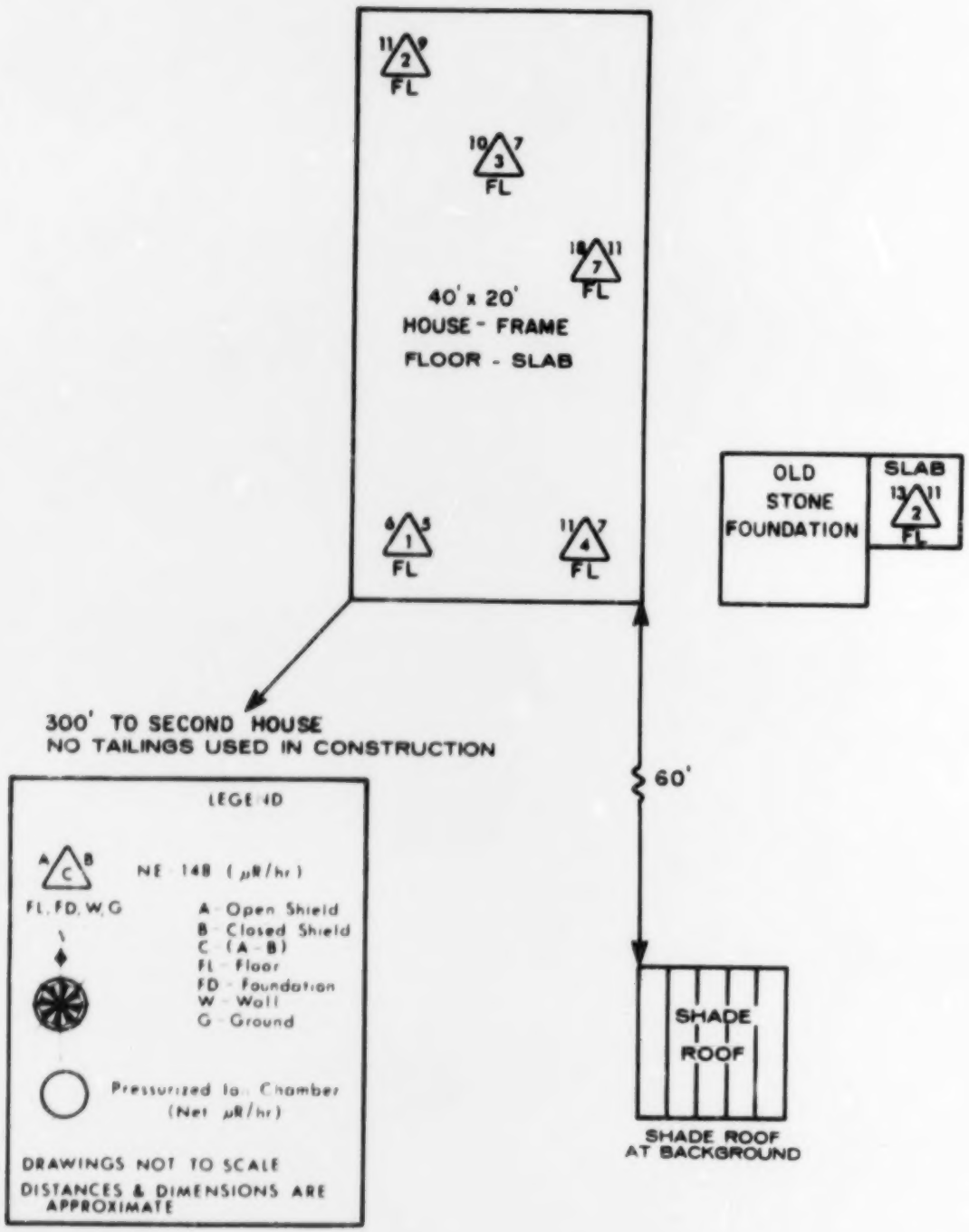


Figure 18